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(54) **PORTABLE STOCKER AND METHOD OF USING SAME**

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H01L 21/677 (2006.01)

(52) **U.S. Cl.**
CPC ***H01L 21/67775*** (2013.01); ***H01L 21/67766*** (2013.01)

(58) **Field of Classification Search**
CPC H01L 21/6773; H01L 21/67775; B65B 31/028
USPC 414/331.04, 416.03, 937
See application file for complete search history.

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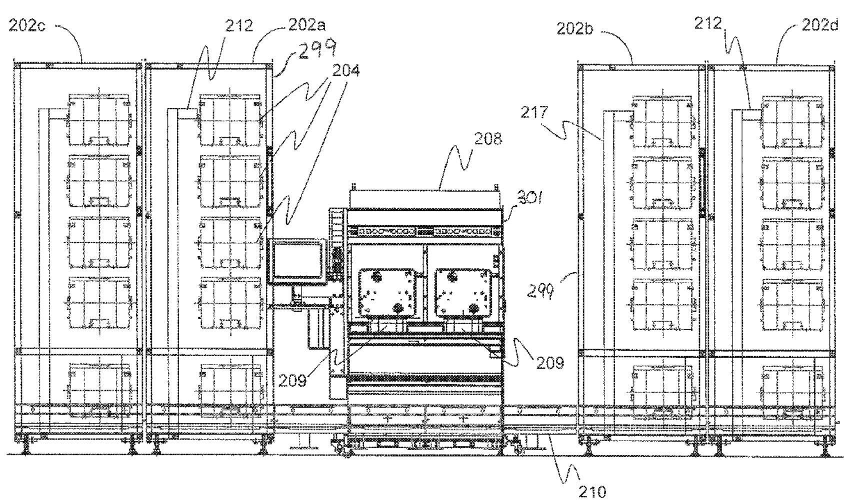
(57) **ABSTRACT**

A system comprising a conveyor. A semiconductor processing tool has a lifter port. The tool is positioned near the conveyor, such that the lifter port is configured to transport a Front Opening Unified Pod (FOUP) between the conveyor and the lifter port. An upstream stocker and a downstream stocker are both co-located with the conveyor and the tool. The upstream and downstream stockers each have a respective storage space for the FOUP and a respective robotic device configured to transport the FOUP between its respective storage space and the conveyor. The upstream stocker is configured to receive the FOUP from an overhead transport (OHT) and deliver the FOUP to the conveyor. The downstream stocker is configured to receive the FOUP from the conveyor and deliver the FOUP to the OHT.

16 Claims, 7 Drawing Sheets



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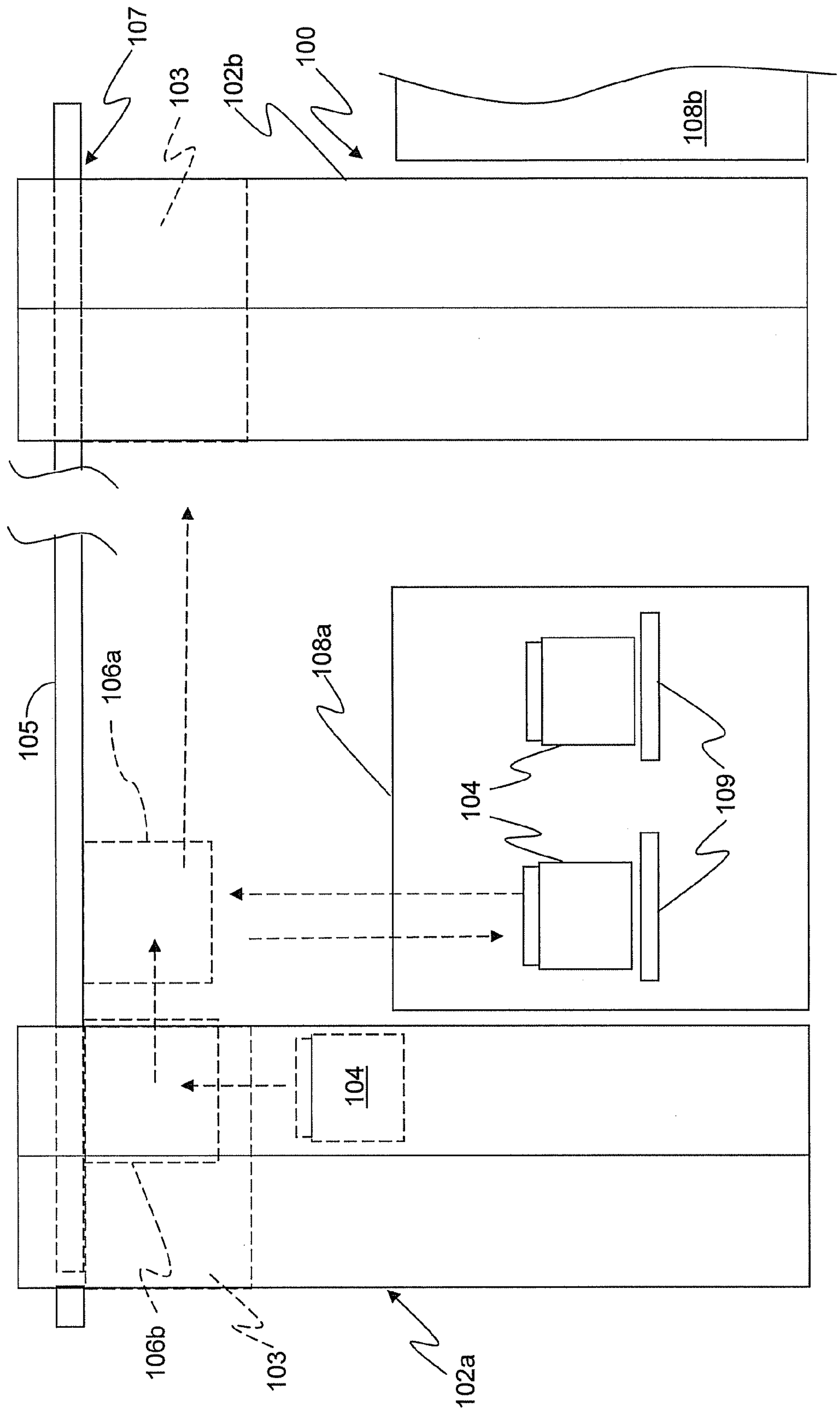


(PRIOR ART)
FIG. 1

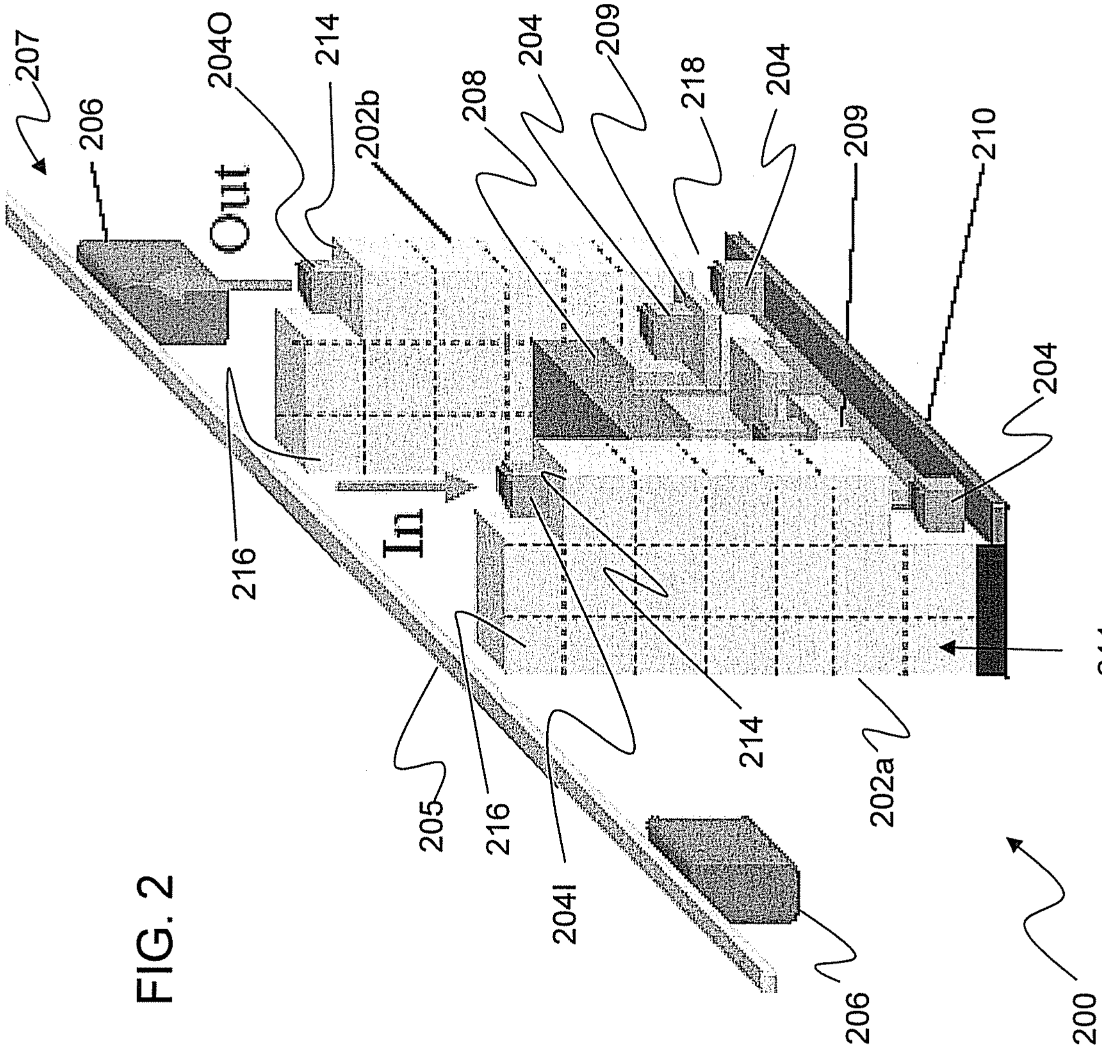
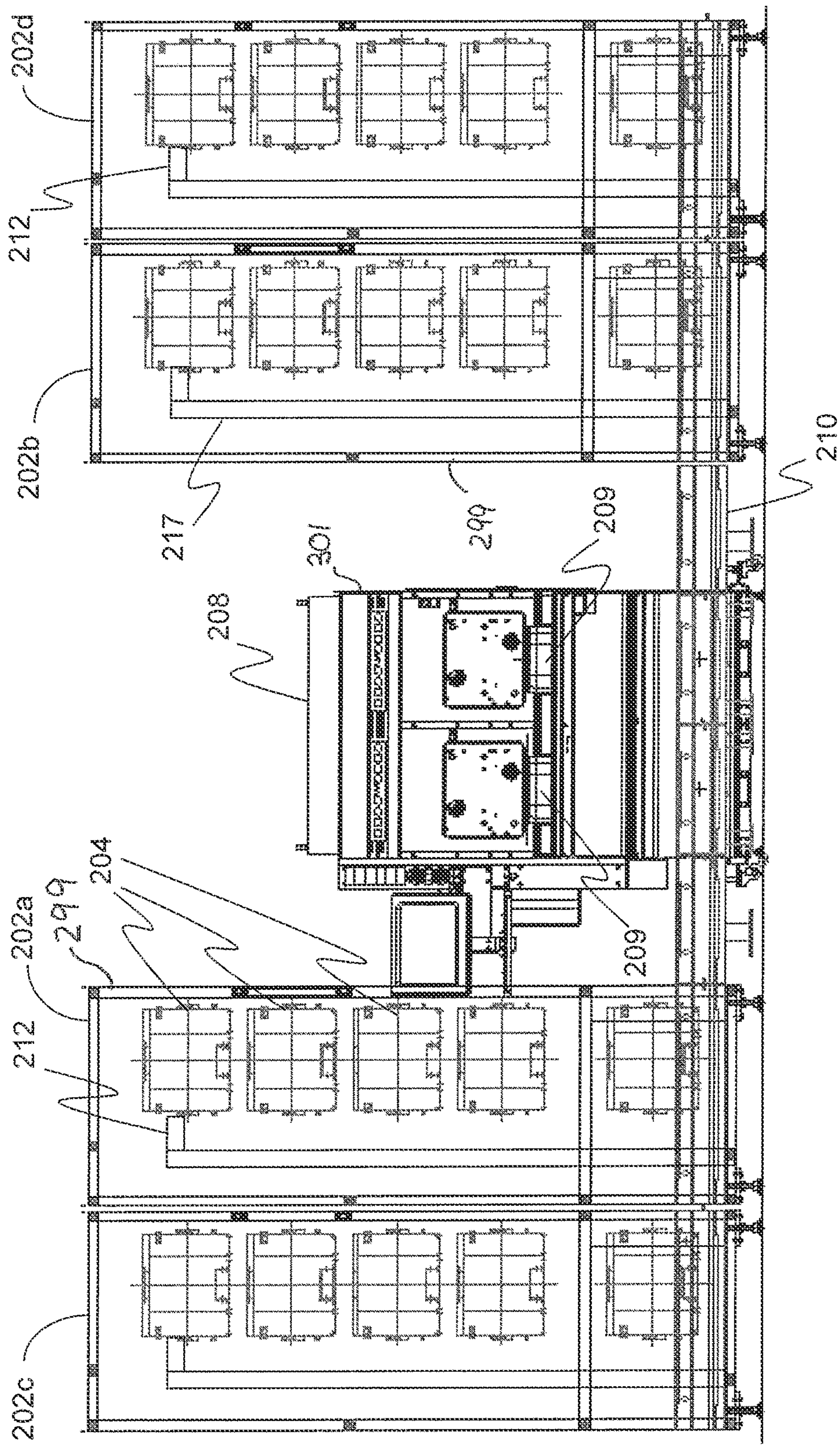
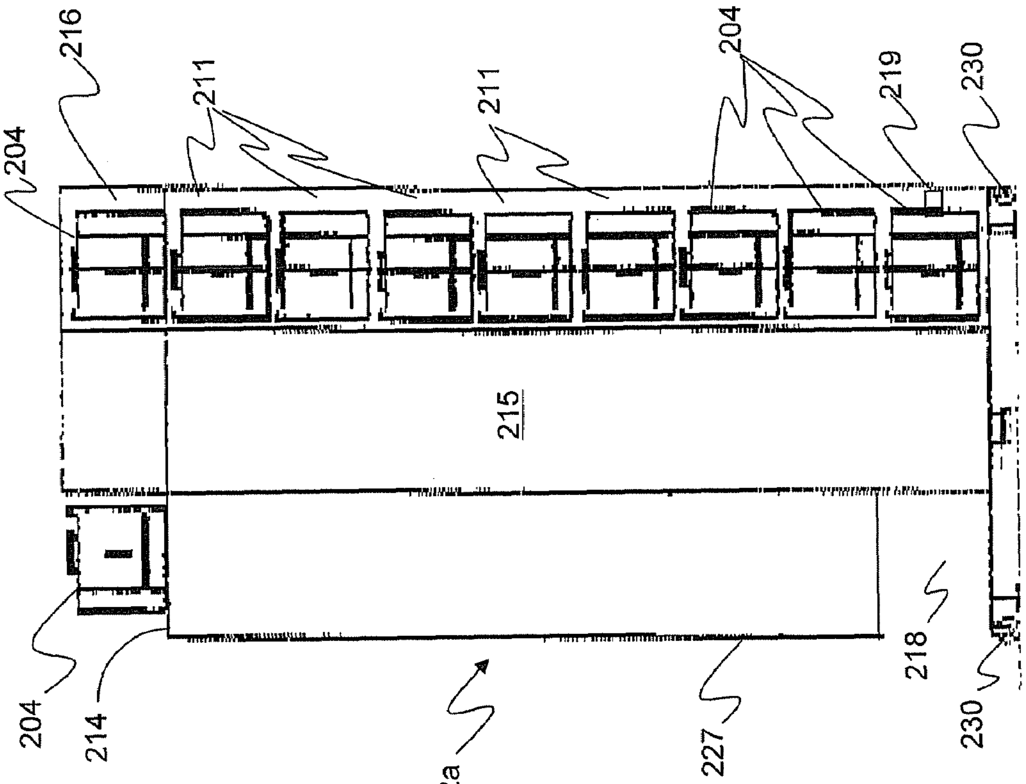

207
206
204O
214
202b
Out
208
204
209
218
204
209
210
216
In
204
211
214
202a
205
216
204I
206
200

FIG. 2

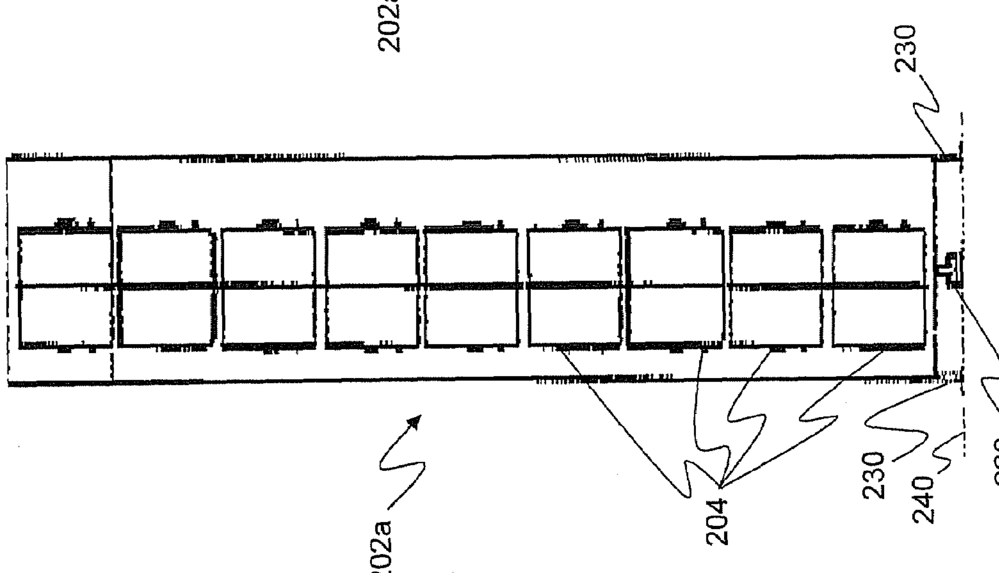
FIG. 3





204
216
211
211
204
219
230
215
204
214
202a
227
218
230

FIG. 4B



230
202a
204
230
240
220

FIG. 4A

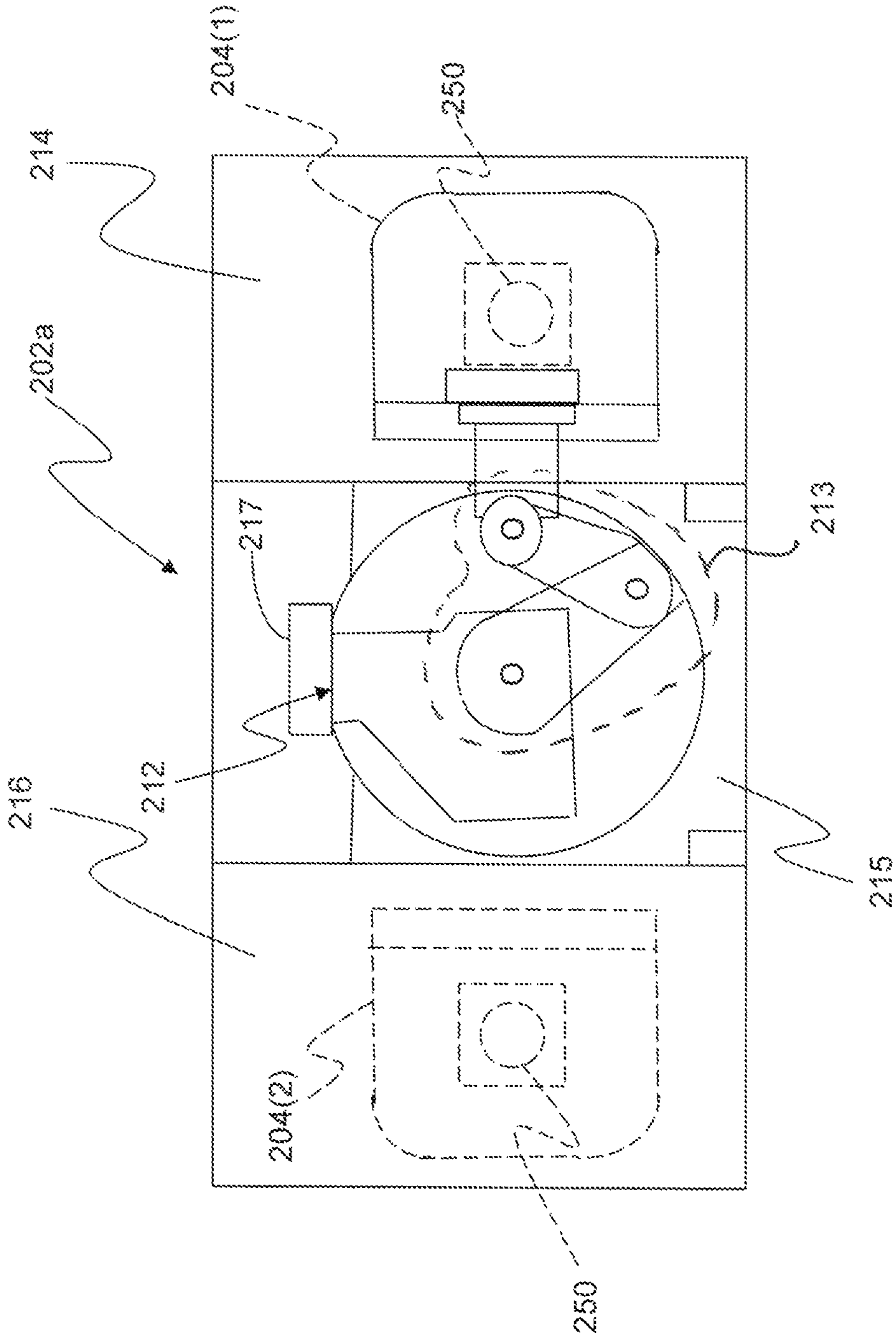


FIG. 5

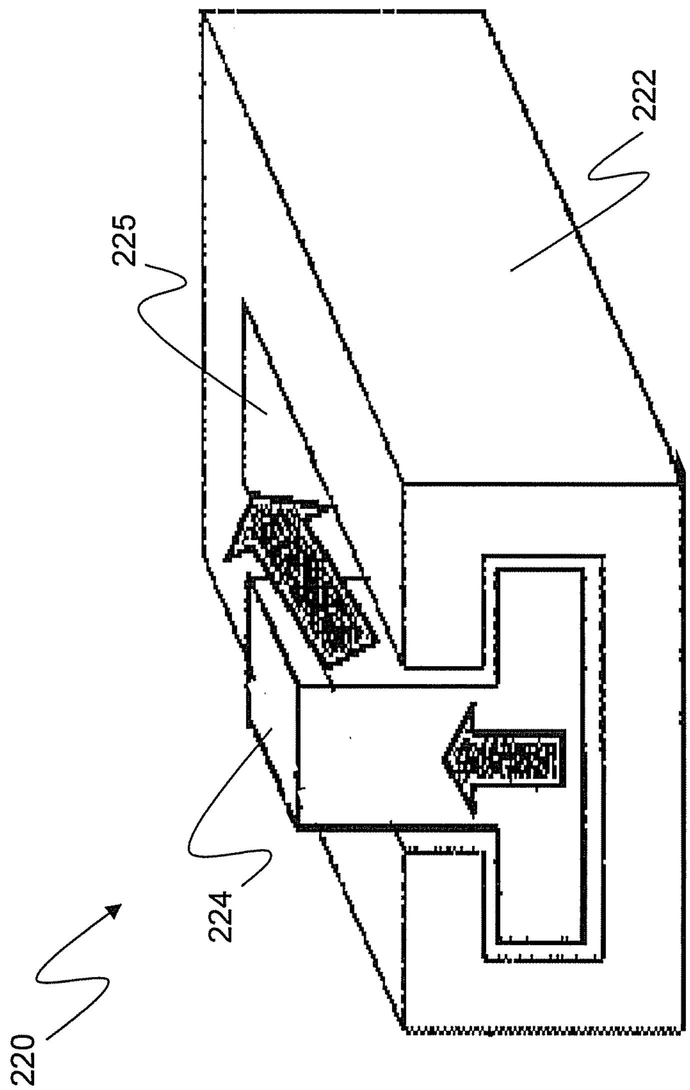
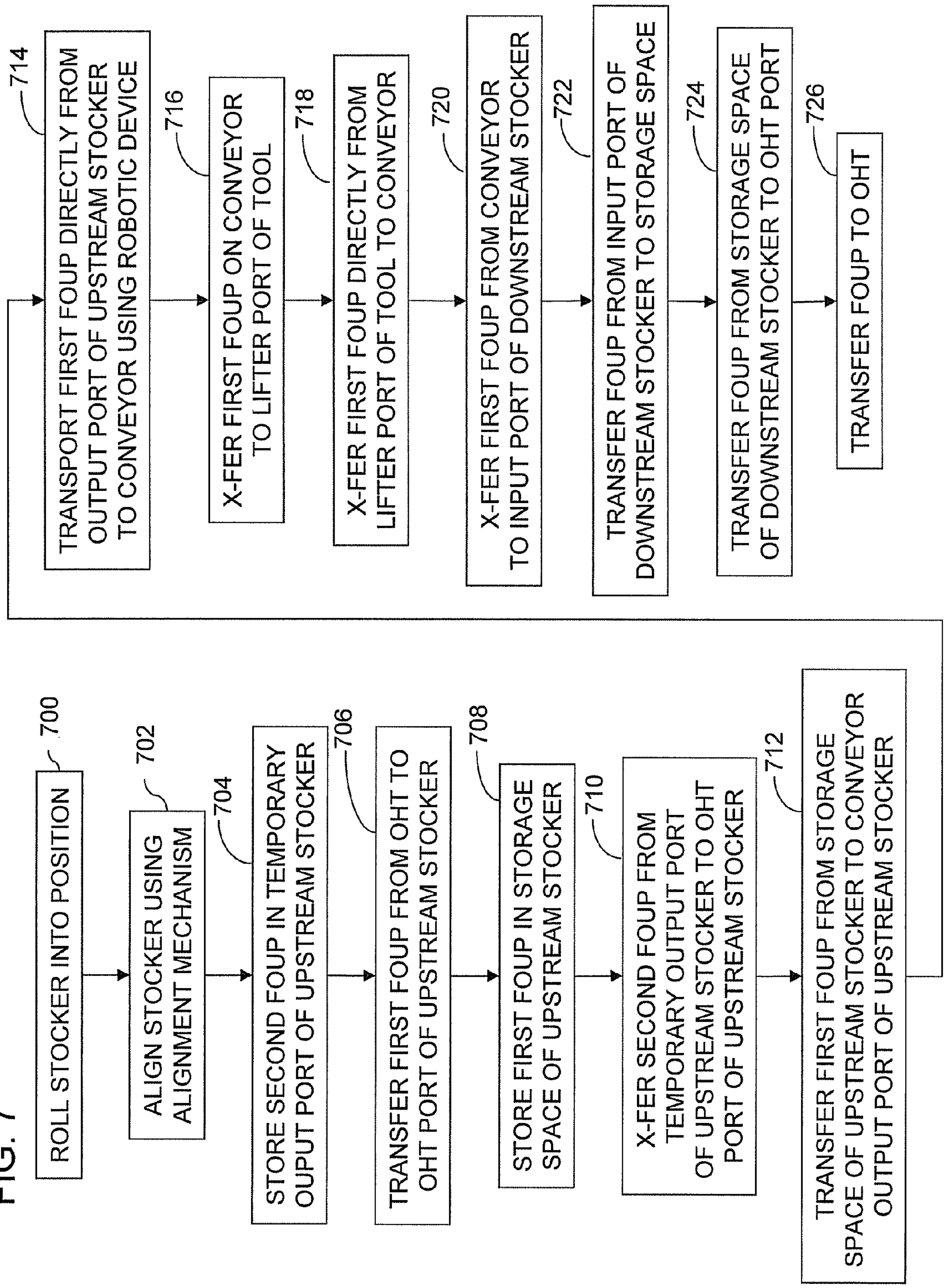


FIG. 6

FIG. 7


700
ROLL STOCKER INTO POSITION
702
ALIGN STOCKER USING ALIGNMENT MECHANISM
704
STORE SECOND FOUP IN TEMPORARY OUPUT PORT OF UPSTREAM STOCKER
706
TRANSFER FIRST FOUP FROM OHT TO OHT PORT OF UPSTREAM STOCKER
708
STORE FIRST FOUP IN STORAGE SPACE OF UPSTREAM STOCKER
710
X-FER SECOND FOUP FROM TEMPORARY OUTPUT PORT OF UPSTREAM STOCKER TO OHT PORT OF UPSTREAM STOCKER
712
TRANSFER FIRST FOUP FROM STORAGE SPACE OF UPSTREAM STOCKER TO CONVEYOR OUTPUT PORT OF UPSTREAM STOCKER
714
TRANSPORT FIRST FOUP DIRECTLY FROM OUTPUT PORT OF UPSTREAM STOCKER TO CONVEYOR USING ROBOTIC DEVICE
716
X-FER FIRST FOUP ON CONVEYOR TO LIFTER PORT OF TOOL
718
X-FER FIRST FOUP DIRECTLY FROM LIFTER PORT OF TOOL TO CONVEYOR
720
X-FER FIRST FOUP FROM CONVEYOR TO INPUT PORT OF DOWNSTREAM STOCKER
722
TRANSFER FOUP FROM INPUT PORT OF DOWNSTREAM STOCKER TO STORAGE SPACE
724
TRANSFER FOUP FROM STORAGE SPACE OF DOWNSTREAM STOCKER TO OHT PORT
726
TRANSFER FOUP TO OHT

PORTABLE STOCKER AND METHOD OF USING SAME

FIELD OF THE INVENTION

The present invention relates to automated materials handling systems for semiconductor fabrication facilities.

BACKGROUND

Semiconductor integrated circuit fabrication facilities ("fabs") are highly automated. Movement of semiconductor wafers between various process tools is accomplished by an automated material handling system (AMHS). The wafers are typically transported through the fab in Front Opening Unified Pods (FOUPs), wafer holding devices capable of holding up to 25 wafers of 300 mm diameter.

A FOUP is a specialized enclosure designed to hold semiconductor wafers securely and safely in a controlled environment, and to allow the wafers to be removed for processing or measurement by tools equipped with appropriate load ports and robotic handling systems. Fins in the FOUP hold the wafers in place, and a front opening door allows robot handling mechanisms to access the wafers directly from the FOUP. A FOUP can be located on a load port, and can be manipulated by the AMHS.

The AMHS transport vehicles travel relatively long distances to carry the FOUPs between tools that perform different fabrication processes. The tools may be located within different portions of the same building, or in different buildings.

FIG. **1** is a diagram of a system **100**. The system has a plurality of pieces of fabrication equipment (tools) **108***a*, **108***b*, which may be separated from each other by a relatively large distance (e.g., tens or hundreds of meters). Typically each tool **108***a* (**108***b*) has an associated stocker **102***a* (**102***b*) for wafer cassettes within the FOUPs **104**, holding wafer lots waiting to be processed by the associated tool **108***a* (**108***b*). FOUPs **104** are transferred from a load port **103** of a stocker **102***a* to a tool **108***a* via an overhead transport system (OHT) **107** having transport vehicles **106***a*, **106***b*, in a sequential order according to lot orders communicated from a real time dispatching system (not shown). Lots not queued for processing within the associated tool **108***a* remain in a wafer cassette within an associated FOUP **104**; the associated FOUP **104** is routed to vehicle **106***a* of the overhead transport system **107** for transporting the FOUP **104** to the stocker **102***b* associated with the next tool **108***b* to be visited, for further processing.

FIG. **1** shows the stockers **102***a*, **102***b* installed beside the tools **108***a*, **108***b*, respectively. In a typical operating sequence, the processed lot **104** in the load port **109** of tool **108***a* is removed from the load port **109** and transported by an OHT vehicle **106***a* to the stocker **102***b* at the next destination tool **108***b*. The OHT vehicle **106***a* moves in one direction along its track **105**. The next lot which is going to be processed is transported by another OHT vehicle **106***b* to the load port **109** of the tool **108***a*, from the stocker **102***a*. It takes a comparatively long time to finish swapping FOUPs, in part because two different vehicles **106***a*, **106***b* are used to remove a first FOUP **104** from the load port **109** of tool **108***a* and to transport a second FOUP from the stocker **102***a* to the load port **109**. There may be a delay of about two minutes between the visit by vehicle **106***a* and the visit by vehicle **106***b*.

The long FOUP swap time results in reduced tool duty cycle and reduced tool productivity.

SUMMARY OF THE INVENTION

In some embodiments, a system comprises a conveyor. A semiconductor processing tool has a lifter port. The tool is positioned near the conveyor, such that the lifter port is configured to receive a Front Opening Unified Pod (FOUP) from the conveyor and transport the FOUP, where the FOUP is adapted for storing a wafer. At least one stocker is co-located with the conveyor and the tool. The at least one stocker has a storage space for the FOUP and a robotic device configured to transport the FOUP between the storage space and the conveyor.

In some embodiments, a system comprises a conveyor. A semiconductor processing tool has a lifter port. The tool is positioned near the conveyor, such that the lifter port is configured to transport a Front Opening Unified Pod (FOUP) between the conveyor and the lifter port. An upstream stocker and a downstream stocker are both co-located with the conveyor and the tool. The upstream and downstream stockers each have a respective storage space for the FOUP and a respective robotic device configured to transport the FOUP between its respective storage space and the conveyor. The upstream stocker is configured to receive the FOUP from an overhead transport (OHT) and deliver the FOUP to the conveyor. The downstream stocker is configured to receive the FOUP from the conveyor and deliver the FOUP to the OHT.

In some embodiments, a method comprises providing at least a first stocker having a robotic device, a conveyor; and a semiconductor processing tool having a lifter port. The first stocker, conveyor and tool are co-located with each other. A Front Opening Unified Pod (FOUP) is transported directly from an output port of the first stocker to the conveyor using the robotic device of the first stocker. The FOUP is transported on the conveyor directly to the lifter port of the tool.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagram of a conventional system.

FIG. **2** is an isometric view of an embodiment of the present invention.

FIG. **3** is a front elevation view of the system of FIG. **2**.

FIG. **4**A is a cutaway rear elevation view of the stocker of FIG. **2**.

FIG. **4**B is a side elevation view of the stocker of FIG. **2**.

FIG. **5** is a top plan view of the stocker of FIG. **2**.

FIG. **6** is an enlarged view of the alignment mechanism of FIG. **4**A.

FIG. **7** is a flow chart of a method of operating the system shown in FIGS. **2**-**6**.

DETAILED DESCRIPTION

This description of the exemplary embodiments is intended to be read in connection with the accompanying drawings, which are to be considered part of the entire written description. In the description, relative terms such as "lower," "upper," "horizontal," "vertical,", "above," "below," "up," "down," "top" and "bottom" as well as derivative thereof (e.g., "horizontally," "downwardly," "upwardly," etc.) should be construed to refer to the orientation as then described or as shown in the drawing under discussion. These relative terms are for convenience of description and do not require that the apparatus be constructed or operated in a particular orientation. Terms concerning attachments, coupling and the like, such as "connected" and "interconnected," refer to a relationship wherein structures are secured or attached to one another either directly or indirectly through intervening structures, as well as both movable or rigid attachments or relationships, unless expressly described otherwise.

FIGS. **2**-**6** are diagrams of an exemplary system **200** having a tool **208** and at least one near-tool buffer **202***a*, **202***b*, which may be mini-stockers. FIG. **2** is an isometric view of the system **200**. FIGS. **3**-**4**B are partial cutaway drawings, to show the storage of FOUPs **204** inside the stocker **202***a* of FIG. **2**, but one of ordinary skill understands that the stocker **202***a* has a housing with external walls, as shown in FIG. **2**. The only FOUPs **104** that are actually visible are the FOUPs at the OHT port **214** and the conveyor port **218** (FIGS. **2** and **4**B). As shown in FIG. **2**, an exemplary system **200** includes an upstream stocker **202***a*, a conveyor **210**, a tool **208**, and a downstream stocker **202***b*.

Referring now to FIG. **2**, the semiconductor processing tool **208** has a lifter port **209** capable of controlled vertical movement between a height of the conveyor **210** and a height of the wafer port of tool **208**. The tool **208** is positioned near the conveyor **210**, such that the lifter port **209** is configured to receive a FOUP **204** adapted for storing a wafer **250** (FIG. **4**) from the conveyor **210** and transport the FOUP **204**. The tool may use the Directly loaded Transport (DLT) technique by Asyst Technologies Inc. of Fremont, Calif. which comprises floor conveyors **210** and lifting load ports **209**. The lifting port **209** includes a robotic device to retrieve a FOUP from the conveyor **210** and raise the FOUP to the tool port. The conveyor **210** runs underneath a shelf in front of the load port of tool **208**, which has a lifting mechanism **209**. A ledge on the load port can move up or down, retracting beneath the level of the conveyor **210**. A FOUP rolls out of the mini-stocker **202***a* and moves quickly across to the lifting load port **209** of the tool **208**.

At least one stocker **202***a*-**202***d* is co-located with the conveyor **210** and the tool **208**. Each of the stockers **202***a*-**202***d* has a storage space for the FOUP **204** and a robotic device **212** configured to transport the FOUP between the storage space **211** and the conveyor **210**. In some embodiments, the stockers **202***a*-**202***d* are mini-stockers. The mini-stockers are modular in design and small enough to be portable. A system **200** having mini-stockers **202***a*-**202***d* can be reconfigured wherever and whenever it is convenient, for example, to perform preventive maintenance on a stocker, or to realize small lot operation. Additional mini-stockers **202***c*, **202***d* may be added to or removed from the system **200** as desired. A conveyor of different length is substituted when stockers **202***c*, **202***d* are added to or removed from system **200**.

The system **200** integrates the near-tool buffer (mini-stockers) **202***a*-**202***d* with the DLT **209** to reduce the swap time of FOUPs (The swap time may refer to the time period between delivery of a first FOUP from the OHT vehicle **206** to the stocker **202***a* and delivery of a second FOUP from the stocker **202***a* to the same OHT vehicle **206** or the next available OHT vehicle. The swap time may also refer to the time period between removal of a FOUP from the tool **208** by the lifting port **209** and delivery of the next FOUP from the lifting port **209** to the tool **208**.)

The system **200** can store the lots in the near-tool buffers **202***a*, **202***b* and transport the lots from the buffer **202***a* to the load port **209** of the tool **208** or from the tool's load port to the buffers **202***b* on the conveyor **210**, without using the OHT vehicle **206**.

Although the system **200** is shown with four stockers, **202***a*-**202***d*, other embodiments, have a single upstream stocker **202***a* and a single downstream stocker **202***b*. The upstream stocker **202***a* is configured to receive a FOUP **204** from an overhead transport system (OHT) vehicle **206** and deliver the FOUP to the conveyor **210**. The downstream stocker **202***b* is configured to receive the FOUP **204** from the conveyor **210** and deliver the FOUP to the OHT vehicle **206**. Further embodiments may have any desired number of stockers **202***a*-**202***d*.

The upstream and downstream stockers **202***a*, **202***b*, respectively each have at least one storage space **211** with a shelf for storing the FOUPs **204** and a respective robotic device **212** configured to transport the FOUPs **204** between the storage spaces **211** and the conveyor **210**.

In some embodiments, the stocker **202***a*, **202***b* is mounted on wheels **230** for moving the stocker. In some embodiments, the stocker **202***a*, **202***b* is portable and has an alignment mechanism **220** for positioning the stocker relative to the conveyor **210** and an overhead transport **207**. In some embodiments, the alignment mechanism **220** includes at least one alignment member **224** mounted at a bottom of the stocker **202***a*, **202***b*. In some embodiments, the alignment mechanism **220** further includes at least one fixed member **222** adapted to engage the at least one alignment member **224**. The at least one fixed member **222** is mounted to a surface (e.g., floor **240** or raised floor) on which the stocker **202***a* is to be located, such that positioning the stocker **202***a* with the at least one alignment member **224** engaging the at least one fixed member **222** positions the stocker **202***a* with the robotic device **212** thereof positioned to transport the FOUP **204** between the storage space **211** and the conveyor **210** and between the storage space **211** and the overhead transport **207**. In one embodiment, the at least one alignment member **224** is a T-shaped rail, and the at least one fixed member **222** has a T-shaped opening **225**.

Other alignment mechanisms may be used. For example the alignment member may have a variety of cross-sectional shapes, and any number of alignment members (with corresponding fixed members) may be included. Also, although FIG. **6** shows a male member on the stocker **202***a* and a female fixed member, in other embodiments, the stocker has a female member, and the fixed member is a male member. In other embodiments, the stocker has a male alignment member and a female alignment member, and corresponding female and male members are provided on the fixed surface.

In some embodiments, as shown in FIGS. **2**, **3**, **4**A and **4**B, the stocker **202***a* has a single vertical column containing a plurality of storage spaces **211** for storing a plurality of FOUPs **204**, and the robotic device **212** is capable of vertical movement among the plurality of storage spaces. FIG. **3**. shows external walls **299** of stockers **202***a* and **202***b*, and external walls **301** of tool **208**. A space is present between the facing external walls **299** and **301**. Each stocker **202***a*, **202***b* is thus spaced apart from tool **208**. As best seen in FIGS. **2**, **4**B and **5**, a first port (the stocker OHT port) **214** of stockers **202***a*, **202***b* is usable as an input port for receiving a first FOUP **204**(**1**) from an overhead transport system (OHT) vehicle **206**, or as an output port for delivering a second FOUP **204**(**2**) to the vehicle **206**.

In embodiments having a single vertical column the mini-stocker **202***a* can have a minimum size and weight given a desired height that permits the mini-stocker to exchange FOUPs with the OHT **207** and the conveyor **210**, enhancing portability. Also, a lightweight robotic device **212** that only has translation in the vertical direction may be used with a mini-stocker having a single column design (A three pin mechanism **213** extends and retracts without a horizontal translation of the entire robotic device head **212**). The single column design also provides flexibility to maximize the use of any available space near the tool **208**, by adding as few or as many stockers **202***a* as the available space permits.

Additional stocker space may be added by adding another modular mini-stocker to any given system **200**. The additional stockers **202***c*, **202***d* may be operatively coupled to the existing stockers **202***a*, **202***b* and the tool **208** by substituting a longer conveyor **210** capable of reaching the conveyor ports

218 of all of the stockers **202**a-**202**d. Alternatively, if the existing conveyor **210** is of a modular, extendible type, then one or more sections may be added to the conveyor **210** to increase its length sufficiently to service stockers **202**c and **202**d.

Reference is made to FIG. **5**, which is a top plan view of stocker **202**a. In some embodiments, a first FOUP **204**(**1**) is received from, and a second FOUP **204**(**2**) is delivered to, the same OHT vehicle **206** during a single visit of the vehicle **206** to the stocker OHT port **214**. A second port (temporary output port) **216** is usable as a storage buffer for temporarily storing the second FOUP **204**(**2**) while the first FOUP **204**(**1**) is received from vehicle **206** of OHT **207** and moved to one of the storage spaces **211**. The temporary output port **216** (FIGS. **4**B, **5**) is used for temporarily holding the second FOUP **204**(**2**). Once the robotic device **212** has moved the incoming FOUP **204**(**1**) to one of the storage spaces **211**, the second FOUP **204**(**2**) is ready at the temporary output port **216** for rapid retrieval by robotic device **212**, transfer to the OHT port **214** by the robotic device **212**, and delivery by the robotic device **212** to the OHT **207** during a single visit by the vehicle **206** to the stocker **202**a.

The robotic device **212** is capable of moving the first FOUP **204**(**1**) from the stocker OHT port **214** to a first one of the plurality of storage spaces **211**, and is capable of moving the second FOUP **204**(**2**) from a second one of the plurality of storage spaces **211** to the temporary output port **216**.

In some embodiments, the conveyor **210** is reversible, the stocker **202**b is also able to receive a FOUP **204** from the OHT vehicle **206** and deliver the FOUP **204** to the conveyor **210**, and the upstream stocker **202**a is also able to receive the FOUP **204** from the conveyor **210** and deliver the FOUP **204** to the OHT vehicle **206**. Essentially, either stocker **202**a, **202**b can serve as an "upstream" stocker to provide a FOUP **204** to the tool **208**, and either stocker **202**a, **202**b can serve as a "downstream" stocker to receive a FOUP **204** from the tool **208**. In the case where the OHT vehicle **206** only moves in one direction, the ability to transfer a FOUP from the nominal downstream stocker **202**b to the tool **208** via the conveyor **210** avoids a long delay that would otherwise occur if a FOUP **204** from downstream stocker **202**b is transported to the tool **208** via vehicle **206**, and has to follow the entire length of the OHT track **205** to reach the tool **208** from stocker **202**b.

Referring again to FIGS. **2** and **5**, the robotic device **212** is configured to transport the FOUP **204** directly from a storage space **211** of the stocker **202**a to the conveyor **210** via conveyor port **218**, or directly from the conveyor **210** to the storage space **211** (i.e., without using the OHT vehicle **206** to move the FOUP **204** between the stocker **202**a and the lifter port **209**). The robotic device **212** is also configured to transport the FOUP **204** directly from an OHT port **214** of the stocker **202**a to the storage space **211**, or from the OHT port **214** to the conveyor **210** (without placing the FOUP **204** in a storage space **211**).

The robotic device **212** travels vertically within the central column **215** of the stocker **202**a. In some embodiments, the robotic device **212** includes a rotating head mechanism **213** having three kinetic pins. Rotation of the three-pin mechanism **213** by 90 degrees causes the mechanism **213** to extend or retract, causing linear translation of the FOUP **204** into or out from one of the storage spaces **211**, the OHT port **214**, or the temporary storage port **216**. In some embodiments, the robotic devices **212** are provided by Daifuku Co. Ltd of Osaka, Japan, or Muratec (Murata Machinery, USA, Inc.). of Charlotte, N.C. In other embodiments, different robotic devices may be used, optionally having the same or additional degrees of freedom in motion.

After the FOUP **204** is moved from one of the storage spaces **211** or ports **214**, **216** into the central column **215** of the stocker **202**a, the rotating head **213** of the robotic device **212** moves vertically along its track **217** to deliver the FOUP **204** to one of the storage spaces **211** or to the conveyor **210**. As best seen in FIG. **2**, the rotating head **213** of the robotic device **212** is configured to deliver the FOUP to the conveyor **210** via conveyor port **218**, the same way a FOUP is delivered to the OHT port **214**. The head **213** rotates, causing extension of the three-pin mechanism to move the FOUP **204** out from the central column **215** to the conveyor port **218** of the stocker **202**a, from which it is loaded onto the conveyor **210**.

In some embodiments, the stocker **202**a includes an optional port **219** (FIG. **4**B) for charging the FOUP **204** with an atmosphere of nitrogen or clean dry air.

FIG. **7** is a flow chart of a method of using the system **200** comprising at least a first stocker having a robotic device, a conveyor, and a semiconductor processing tool having a lifter port, where the first stocker, conveyor and tool are co-located with each other.

At step **700**, at least one stocker (e.g., the upstream stocker **202**a) is rolled into position on a set of integrally mounted wheels **230**.

At step **702**, the first stocker **202**a is aligned with the conveyor **210** using an alignment mechanism **220** including a component **224** integral to a housing **227** of the first stocker **202**a. For example, in the case of the stocker **202**a, the stocker is rolled into place so that the male alignment member **224** is received by the female fixed member **222**.

At step **704**, a second FOUP **204** is stored in a temporary output port **216** of the first stocker **202**a, to allow a first FOUP to be transferred from the OHT vehicle **206** to a storage space **211** by way of the OHT port **214**. By storing the second FOUP **204** in the temporary output port **216**, the second FOUP is in position, ready to be quickly moved to the OHT port **214** for delivery to an OHT vehicle **206**, during the same visit in which vehicle **206** delivers the first FOUP **204** to the stocker **202**a for storage in a storage space **211**, or delivery to the conveyor **210**.

At step **706**, while the second FOUP **204** waits in the temporary output port **216**, the first FOUP **204** is transferred from the vehicle **206** of the OHT **207** to the input port (OHT port **214**) of the first stocker **202**a.

At step **708**, the first FOUP **204** is stored in a storage space **211** of the first (upstream) stocker **202**a. To accomplish this, the three-pin mechanism **213** of the robotic device **212** draws the FOUP **204** into the central column **215** of the stocker **202**a. Then the robotic device **212** travels vertically along its track **217** to the height of the storage space **211**, and the three pin mechanism **213** extends to move the FOUP **204** into the storage space.

At step **710**, the robotic device **212** transfers the second FOUP **204** from the temporary output port **216** of the first stocker **202**a to the OHT port **214** of the stocker **202**a. This includes rotating the head **213** to engage the FOUP **204** in the temporary output port **216**, rotating the head to withdraw that FOUP into the center column **215**, and rotating the head **213** of robotic device **212** again, to extend the three-pin mechanism **213** to deposit the FOUP **204** in the OHT port **214**. The OHT vehicle **206** can now retrieve the second FOUP in the same visit during which the first FOUP is input from the vehicle **206** to the stocker **202**a.

At step **712**, the first FOUP **204** is transported from the storage space **211** of the first stocker **202**a to the conveyor output port **218** of the first stocker **202**a. The robotic device **212** withdraws the FOUP **204** from the storage space **211** into the central column **215**, and travels vertically along the track **217** to the conveyor (output) port **218**.

Then, at step **714**, the first FOUP is transported directly from the conveyor output port **218** of the first stocker **202***a* to the conveyor **210** using the robotic device **212** of the first stocker **202***a*.

At step **716**, the first FOUP is transported on the conveyor directly to the lifter port **209** of the tool **208**. The lifter port retrieves the FOUP **204** from the conveyor **210** and moves the FOUP into position for performing a fabrication process step on one of the wafers **250** contained within the FOUP.

At step **718**, after completion of the process in tool **208**, the FOUP is transported directly from the lifter port **209** of the tool **208** to the conveyor **210**.

At step **720**, the first FOUP is transferred from the conveyor **210** to the conveyor (input) port **218** of the downstream stocker **202***b*, using the robotic device **212** of the downstream stocker.

At step **722**, the first FOUP **204** is transported from the input port **218** of the downstream stocker **202***b* to a storage space **211** of the downstream stocker. The downstream stocker **202***b* stores the first FOUP **204** in the storage space **211** of the downstream stocker.

At step **724**, the downstream stocker **202***b* transports the FOUP **204** from the storage space **211** of the downstream stocker to the OHT (output) port **214** of the downstream stocker **202***b*, using the robotic device **212** of the downstream stocker.

At step **726**, the FOUP is transferred from the OHT port **214** of the downstream stocker **202***b* to the next available OHT vehicle **206**. In the case where one OHT vehicle **206** has delivered the first FOUP to upstream stocker **202***a* and retrieved the second FOUP from the upstream stocker **202***a* in the same visit, that same vehicle **206** does not retrieve a FOUP from the downstream stocker **202***b* during the same visit, and another vehicle **206** may be the next available vehicle to retrieve a FOUP from the downstream stocker **202***b*.

One of ordinary skill understands that FIG. **7** is just one example of a sequence of operations. The various movements and transfers of FOUPs using the OHT vehicle **206**, the robotic device **212** and the conveyor **210** may be performed in a variety of different combinations and sequences.

The stockers **202***a* and system **200** described above improve the flexibility and configurability of the fab. The mini-stockers **202***a* can be pre-fabricated by a vendor, and need not be assembled in situ in the fab. Additional mini-stocker units **202***a* can be quickly relocated, aligned, and integrated into system **200** to provide extra storage capacity. For example, extra stocker units **202***a* can be relocated to any location where the work in process (WIP) is expected to be high. The extra capacity can allow more FOUPs to be stored near any given tool and avoid any need to store extra FOUPs in remotely located stockers. This in turn can avoid long delays in transporting FOUPs between the tool **208** and a remotely located stocker.

As the needs of the fab change, the stocker **202***a* can be easily and rapidly moved to another tool or location where extra capacity for storing WIP is desired.

Although the invention has been described in terms of exemplary embodiments, it is not limited thereto. Rather, the appended claims should be construed broadly, to include other variants and embodiments of the invention, which may be made by those skilled in the art without departing from the scope and range of equivalents of the invention.

What is claimed is:

1. A system comprising:

a first stocker having external walls containing a storage space;

a robotic device;

a conveyor;

a semiconductor processing tool having a lifter port; and

an alignment mechanism,

the first stocker, conveyor and semiconductor processing tool being co-located with each other and the first stocker including a set of integrally mounted wheels and configured to be rolled on the wheels;

the robotic device configured to transport a Front Opening Unified Pod (FOUP) directly from an output port of the first stocker to the conveyor;

the conveyor configured to directly transport the FOUP to the lifter port of the semiconductor processing tool, and

the alignment mechanism including a component integral to a housing of the first stocker and a component fixed to a floor or raised floor and configured to align the first stocker with the conveyor.

2. The system of claim **1**, wherein the first stocker has a single vertical column containing a plurality of FOUP storage spaces for storing a plurality of FOUPs, and the robotic device is capable of movement among the plurality of FOUP storage spaces.

3. The system of claim **1**, wherein the first stocker comprises an upstream stocker and further comprising a downstream stocker, the upstream stocker configured to receive the FOUP from an overhead transport (OHT) and deliver the FOUP to the conveyor, and the downstream stocker configured to receive the FOUP from the conveyor and deliver the FOUP to the OHT.

4. The system of claim **3**, wherein;

the conveyor is reversible;

the downstream stocker is further configured to receive the FOUP from the OHT and deliver the FOUP to the conveyor, and

the upstream stocker is further configured to receive the FOUP from the conveyor and deliver the FOUP to the OHT.

5. The system of claim **1**, wherein the first stocker includes a charging port for charging the FOUP with an atmosphere of nitrogen or clean dry air.

6. The system of claim **1**, wherein the first stocker has an inverted T-shaped alignment rail coupled to a bottom surface of the first stocker and adapted to align the first stocker with the conveyor, a of the T of the inverted T-shaped alignment rail being oriented upwardly and coupled to the bottom surface.

7. The system of claim **1**, wherein the robotic device has a rotating head with a three-kinetic pin mechanism adapted to laterally extend or retract the FOUP upon rotation of the head.

8. The system of claim **1**, further comprising an overhead transport (OHT) including a track, disposed above the semiconductor processing tool and the first stocker, and wherein the robotic device is configured to laterally transport the FOUP from the output port to a second port of the first stocker.

9. The system of claim **1**, wherein the alignment mechanism includes at least one inverted T-shaped alignment member coupled to and extending downwardly from a bottom surface of the first stocker, and the component fixed to a floor or raised floor includes at least one fixed member having an inverted T-shaped opening extending downwardly from a top surface of the fixed member and adapted to engage the at least one inverted T-shaped alignment member, wherein the at least one inverted T-shaped alignment member is a T-shaped rail with a stem portion of the T of the inverted T-shaped alignment member oriented upwardly and coupled to the bottom surface.

10. The system of claim **9**, wherein the at least one inverted T-shaped alignment member is configured to be engaged with the at least one fixed member such that the first stocker is positioned to transport the FOUP between the storage space and the conveyor and between the storage space and an overhead transport.

11. A method comprising:

(a) providing at least a first stocker having external walls containing a storage space; a robotic device; a conveyor; and, a semiconductor processing tool having a lifter port, the first stocker, conveyor and tool being co-located with each other;

(b) transporting a Front Opening Unified Pod (FOUP) directly from an output port of the first stocker to the conveyor using the robotic device of the first stocker; and

(c) transporting the FOUP on the conveyor directly to the lifter port of the tool,

wherein step (a) includes:

rolling the first stocker into position on a set of integrally mounted wheels thereof; and

aligning the first stocker with the conveyor using an alignment mechanism including a component integral to a housing of the first stocker and a component fixed to a floor or raised floor.

12. The method of claim **11**, further comprising:

(a1)) transferring the FOUP from an overhead transport (OHT) to an input port of the first stocker;

(a2) storing the FOUP in the storage space of the first stocker; and

(a3) transporting the FOUP from the storage space of the first stocker to the output port of the first stocker, before step (b).

13. The method of claim **12**, further comprising:

storing a second FOUP in a temporary output port of the first stocker; and

transferring the second FOUP from the temporary output port of the first stocker to an OHT port of the stocker.

14. The method of claim **11**, wherein the at least a first stocker further comprises a downstream stocker having an input port and a robotic device, the method further comprising:

(d) transporting the FOUP directly from the lifter port of the tool to the conveyor;

(e) transporting the FOUP directly from the conveyor to the input port of the downstream stocker using the robotic device of the downstream stocker.

15. The method of claim **14**, further comprising:

(a1)) transferring the FOUP from an overhead transport (OHT) to an input port of the first stocker;

(a2) storing the FOUP in the storage space of the first stocker;

(a3) transporting the FOUP from the storage space of the first stocker to the output port of the first stocker, before step (b);

(e1) transporting the FOUP from the input port of the downstream stocker to a storage space of the downstream stocker, after step (e);

(e2) storing the FOUP in the storage space of the downstream stocker; and

(e3) transporting the FOUP from the storage space of the downstream stocker to an output port of the downstream stocker using the robotic device of the downstream stocker.

16. The method of claim **11**, further comprising:

rotating a head of the robotic device having a rotating head with a three-kinetic pin mechanism to extend the arm for receiving a first FOUP from an OHT vehicle and for providing a second FOUP to the OHT vehicle, wherein the second FOUP is temporarily stored in a second port on the top of the stocker while the first FOUP is received from the OHT.

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